dogs, containing *C. thous* (=*cancrivorus*) and *vetulus*, and by uniting his Sacaline and Lupine sections. Possibly these sections contain groups worthy of subgeneric, if not of generic, recognition: *C. antarcticus* and *C. thous*, for example, may be subgenerically or generically separated by the structure of the mandible; but I do not see how *C. latrans* is to be distinguished other than specifically from such forms as *C. pallipes*, *anthus*, or even *lupus*.

30. On the Patella in the Phalacrocoracidæ.

By Dr. R. W. Shufeldt, C.M.Z.S.

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(Plate LXI.*)

While recently employed in preparing a detailed account of the skeleton of Harris's flightless Cormorant (*Nannopterum harrisi*), in which the osteology of that species is compared with that of a number of others of the family, I became interested in the morphology of the patellæ of those birds.

Many years ago I published a number of papers † on the skeleton in the Cormorant, in some of which the patella of the Phalacrocoracidæ was referred to and figures given of it. But my material, at the time to which I refer, was very limited—in fact I think there were but the skeletons of one or two species of those birds at hand, and this included the skeletons of two or three young ones.

In the higher groups of birds the patella, when present, is usually small, and offers but little of value to the avian taxonomist. This, however, is not the case when we come to examine into the osteology of some of the groups occupying lower positions in the system, and especially is this true of many of the Pygopodine forms and their allies near and remote.

Owen paid but scant attention to this bone of the skeleton in Aves, devoting less than half a paragraph to it, thus:—"The chief of the sesamoid bones in the hind limb is the patella: it is of unusual size in the Penguin, is ossified from two centres, and articulates with the procnemial process of the tibia: it coexists with the long rotular process in the Loon, fig. 34, *l*; it is large and of an angular form in the Musk-duck (*Biziura*): in the Merganser the patella is largest and deeply notched; in the Coot it is elongate. In most aerial birds a patella is wanting" ‡. There is no reference made here either to a Grebe or a Cormorant, and

* For explanation of the Plate see p. 402.

† Shufeldt, R. W. "Osteology of the Cormorant," Science, Dec. 7, 1883, p. 739; Feb. 8, 1884, vol. iii. No. 53, p. 143: *ibid.* Apr. 18, 1884, No. 63, pp. 474, 475.

"Concerning some of the forms assumed by the Patella in Birds," Proc. U.S. Nat. Mus. 1884, vii. pp. 324–331. Numerous text-figures.

"Osteology of the Steganopodes," Mem. Carnegie Museum, Pittsburgh, Pa., Apr. 1903, vol. i. No. 3, Art. 3, pp. 15–70. Plates and many text-figures.

‡ Owen, Richard. Comp. Anat. and Phys. of Vertebrates, vol. ii. p. 83, London 1866.

Professor Owen evidently considered the small, scale-like bone found in the tendon of the extensor femoris, at its insertion, to be the patella in that bird. When I first examined this question, this was likewise my opinion, and in a paper on the patellæ in birds, published in 1884 in the 'Proceedings of the United States National Museum,' I so figured it (fig. 4, p. 328) for *Colymbus septentrionalis* (*Gavia stellata*). This opinion was to some extent qualified later on, when I stated, with respect to the Loons ("Urinatoridæ") that they possess "only a very small, flake-like sesamoid, which occurs in the tendon of the extensor femoris muscle at its insertion, and probably the true patella has coössified in the adult with the elongated cnemial process of the tibio-tarsus"*. Possibly some avian osteologist has published on this subject, but if so, I have not seen the work; and never having been so fortunate myself as to have come into possession of the skeleton of any Loon, secured at the right time to demonstrate the exact composition of the tibio-tarsus in that bird, I am still in doubt on the question. However, it is quite possible—indeed quite likely—that the true patella in Loons (*Gavia*) is, in the adult, completely coössified with the great elongate cnemial process of their tibio-tarsi. The moulding of the patella on the back of this process in Grebes, especially in very old birds, is wonderfully close,—so close in some ligamentous preparations as to deceive the eye upon casual examination.

To settle this interesting point—if it has not as yet been settled—will require the examinations of the skeletons of Loons including those of individuals of the genus of all ages.

At present I am inclined to think that the patella in *Gavia*, in the adult, has been indistinguishably fused with the cnemial process of the tibio-tarsus, for the reason that it is on the road to such a fate in the Grebes (Colymbidæ), and that in all such birds as *Hesperornis*—an ancient ancestor of the Loons—the Penguins, the Cormorants, and some others, the patella is very large.

Then, finding it large in a Grebe, one would naturally look for the same in such forms as Loons, especially when one considers the relationship of these two families.

The statements now being made are, in a way, prefatory, leading up to what I have to say on the patella of the Cormorants. It must be borne in mind in this connection that the patella in Penguins is very large, and grooved obliquely across the anterior face for the tendon of the ambiens muscle †.

* "Concerning the Taxonomy of the North American Pygopodes based upon their Osteology," Jour. Anat. & Phys. London, Jan. 1892, pp. 199–203. The lines quoted are from page 202. In this paper I also give two figures of the skeleton of the thigh and leg of a Grebe, in which the patella is included. One of these figures was reproduced by Coues in his fifth edition of the 'Key,' without acknowledgment (vol. ii, p. 1052, fig. 712).

† Coues, E. "Material for a Monograph of the Spheniscidæ," Proc. Acad. Nat. Sci. Phila. xxiv. 1872.

Watson, Morrison. "Anatomy of the Spheniscidæ" (Rep. Scient. Results of Voyage of H.M.S. 'Challenger,' Zoology, vol. vii. pl. vii. figs. 9 & 10, 1883).

Shufeldt, R. W. Proc. U.S. Nat. Mus. 1884, p. 326, fig. 1. Reproduces from Watson figures of patellæ of *Aptenodytes pennantii* and *Eudyptes chrysocome*. Comments

Personally I have not examined the patella in *Hesperornis* with the view of substantiating Marsh's statement that it is "perforated by a large foramen for the tendon of the ambiens muscle, agreeing in this respect with the patella of the Gannet (*Sula bassana* Briss.)." His several figures of the patella of *Hesperornis regalis* do *not* show this "large foramen" ('Odontornithes,' p. 23, plates xv. and xx. figs. 1–3), while I have yet to see the patella of *Sula bassana* presenting any such perforation for the ambiens muscle as Marsh describes.

However this may be, the fact remains that very radical differences exist with respect to the fate and disposition of the patella and cnemial process of the tibio-tarsus in Grebes, Loons, *Hesperornis*, Penguins, Gannets, Cormorants, and many other different species of water birds. Great differences also exist in the morphology of this sesamoid and the aforesaid apophysis.

This brings us to a point where the patella of the Phalacrocoracidæ may be discussed. For this purpose I have before me the skeletons of several species of Cormorants, all belonging to the Collection of the U.S. National Museum, to which institution I am indebted for the loan of them. It will not be necessary to name these species here or to give their museum numbers, as this information is fully set forth in the explanation of Plate LXI., which appears at the end of this article. As to the 19 figures on the plate, they are reproduced, natural size, from my own grouping and photograph,—the latter having been made direct from the specimens.

Among avian osteologists the general opinion has prevailed that the patella in Cormorants is a big trihedral one, in some way "perforated" for the ambiens muscle.

Garrod found the ambiens muscle present in the family Phalacrocoracidæ; and, in noting that Meckel had not done so, he states that "it is peculiar in that [in the Cormorant] it runs through the substance of the large triangular patella, in a bony canal"*.

In another paper this gifted ornithotomist is still more positive, and in speaking of the "Steganopods," he says: "The ambiens is of fair size; it deeply grooves the large ossified patella; and some of the fibrous ligament overlapping this groove shows traces of ossification; so that in aged birds the groove may be converted into a foramen, as is always the case in *Phalacrocorax*, where the

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made thereon. There is a curious slip in this paper with respect to the description of the patella of the Gannet (*Sula bassana*). On page 362 I state that "Professor Marsh tells us that the patella of *Sula* is perforated by a large foramen for the passage of the tendon of the ambiens muscle." On pages 329 and 330 I quote the entire paragraph from Marsh's 'Odontornithes' (p. 93) where he gives this description of the patella of *Sula* and states on page 327 that "I fail to find any such foramen in the patella of the specimen of *Sula* before me, although it has a shallow, oblique groove across its anterior face that seems to correspond with the one described when speaking of the patella of the Penguin." This statement is supported by a correct figure of the patella in *Sula bassana* (No. 16643, Coll. U.S. Nat. Mus.), and I must believe that the description left us by Prof. Marsh is another of those curious slips of his in the osteology of modern birds.

* Garrod, A. H. "On Certain Muscles of the Thigh of Birds, and on their value in Classification," Pt. I. P. Z. S. 1873, pp. 636, 637 (footnote).

thus formed foramen is far from superficial" *. This is a very interesting statement, and will be commented upon further on in this paper.

Forbes, in describing the anatomy of *Biziura*, makes the statement that "The ambiens muscle is large, and peculiar in that its tendon *perforates* the large-sized triangular patella, just as it does in *Phalacrocorax* and the extinct *Hesperornis*" †.

When referring to this sesamoid in the Cormorants, Coues says, in the fifth edition of his 'Key' (p. 961), that "There is a bulky, free patella, coexistent with a short cnemial apophysis or rotular process of tibia, but perfectly distinct therefrom, as in Grebes." This somewhat ambiguous description is made clearer by an illustration of the patella in "*Phalacrocorax bicristatus*," which he borrowed from a previous paper of mine. Nothing is said with regard to the ambiens or the "perforation" in the patella, so this note is quite useless for present purposes.

From my own various accounts of the patellæ in Cormorants I select the following as best suited to throw light upon the facts I propose to here set forth.

In my above-cited article on the patellæ in birds (Proc. U.S. Nat. Mus. 1884, p. 330, fig. 7) I remark: "In No. 41 of 'Science,' I presented a lateral view of the leg-bones of a Cormorant (*Phalacrocorax*), showing the form of the patella in these birds. The same specimen is given here, only an anterior view is chosen instead of the lateral one.

"This form is a particularly interesting one, and I am not aware of any bird at present that can show a similar condition of the parts in question.

"On the face of it, it almost looks as if a patella had developed of a size equal to the rotular process, and subsequently the two became thoroughly united, and formed one large patella, articulating as shown in the drawings I have made of it. I do not say that this is actually the case, nor were the young of this specimen, which also belong to the collections at the Smithsonian Institution, of a proper age to determine exactly the manner in which this great bulky patella was developed."

Apart from the suspicion expressed in this last paragraph, which will be put into more exact terms further on, there are but two opinions extant, at present, in regard to the development of the patella in the Phalacrocoracidæ. They are the opinions of Garrod and of Forbes, and have been set forth in their own words above.

There is but one construction that can be placed upon Forbes's view of a Cormorant's patella, and that view cannot be successfully defended. It will be noted above that, in his calling

* Garrod, A. H. "Notes on the Anatomy of *Plotus anhinga*," P. Z. S. 1876, p. 340, pl. xxviii. figs. 5, 6. The figures give the patella, indicating the position of the foramen.

† Forbes, Wm. Alex. "Note on some points in the Anatomy of an Australian Duck (*Biziura lobata*)," P. Z. S. 1882, p. 457.

I regret to say that I have never had the opportunity of examining the patella in this duck, and I doubt if we have a skeleton of it in the United States.

attention to the fact that the tendon of the ambiens muscle passes through the patella in Cormorants, he uses the word "perforates" (emphasizing it by the use of italics). Surely he could not have meant that the tendon really did "perforate" or bore its way through the patella as the Cormorant grew and developed? And, after finding its way through the bone (or cartilage) that it duly made attachment at its point of insertion? No such thing has ever occurred in anatomical development, and Forbes was altogether too good an anatomist to have set up any such ridiculous explanation. This being true, and disregarding entirely any such theory or such another possible suggestion as that, in subadult life, the patella of a Cormorant, forming first in elementary cartilage, does, when in that condition, surround the tendon of the ambiens muscle, and afterwards, when the patella has completely ossified in old birds, the aforesaid tendon runs through a foramen, which passes through the middle of it. Barring this, too, as I say, as being a totally untenable suggestion, we are left with but two other possible ways by means of which the ambiens comes to pass through the foraminal canal in the patella of Cormorants.

In discussing these, we are at once confronted with Garrod's opinion in regard to it—an opinion which had never, apparently, occurred to Forbes. Garrod took the view that, inasmuch as in *anhinga* (*Plotus*) the anterior face of the patella is somewhat deeply grooved, and as ligament stretches across that groove to confine the tendon of the ambiens muscle which passes through it, and as this same ligament sometimes "shows traces of ossification,"—hence in Cormorants this also takes place, and the fibrous ligament in them becomes, in old individuals, thoroughly ossified, and we thus find the tendon of the ambiens passing through the bone.

Such an opinion will not hold for an instant in the face of the necessary material to examine into it.

Now in some Cormorants the patella is very large and thick, and the aforesaid foraminal passage, passing through it from side to side, is found but slightly in advance of the middle and above the centre of the bone; so that, had it been a "groove" in the young bird spanned by fibrous ligament, and this ligament subsequently ossified in the adult, that groove must have been a very deep one, and the patella in old birds would, through its form alone, after ossification was complete, exhibit the manner as to how it had come about. Moreover, in connection with this it is very clear that, were the foramen in the patella in Cormorants formed by a groove in front of it being covered over by fibrous ligament in the subadult bird, which ligament later in life ossified, that ossification would be smooth on its anterior face, which is by no means the case, as one may see by a study of the figures in the plate accompanying this paper. For instance, a fibrous ligament, stretching across a deep, narrow groove as a retaining band for the tendon of a muscle, would not, in ossifying, take on any other shape beyond that possessed by the flat ligamentous band; for

instance, as I say, such as has occurred in the patella shown in Pl. LXI. fig. 11 and others. It must stand to reason, then, that Garrod entertained an untenable opinion in this matter.

Coming to the second way in which this foramen could have been formed, it is clear that, in young and subadult individuals, the tendon of the ambiens muscle could be confined by an additional piece of bone or cartilage being placed in front of it, and this added part subsequently ossify and not only form, in the adult, a foraminal passage for the aforesaid muscle or its tendon, but largely add to the bulk of the patella. It might, too, —from the thoroughness of the coössification—cause the atrophy of the muscle and its tendon at that part of the course of the latter across the front of the true patella; and such a result would be brought about by the entire sealing up of the foraminal passage, which not only actually takes place in the patellæ of some Cormorants, but again proves Garrod to have been wrong when he stated that such a foramen or foraminal passage was always present in the patella of Cormorants. See Pl. LXI. fig. 3—*Phalacrocorax penicillatus*—where it has been sealed up entirely, leaving not so much as a trace or a suspicion of its ever having been present there.

In my opinion, the foraminal passage for the ambiens muscle, passing transversely through the patella in the Phalacrocoracidæ, when present, is formed as set forth below, which formation can be demonstrated by the material figured in the plate accompanying this paper. When the foraminal passage is entirely absent it has been absorbed, atrophy of the ambiens probably having ensued.

It would appear that in young Cormorants the ambiens passes in a groove, of the required depth only, obliquely across the anterior face of the patella, which latter is very closely adpressed against the posterior surface of the long cnemial process of the tibio-tarsus,—a condition that persists throughout life in Grebes (Colymbidæ). Coössification between the patella and the upper two-thirds of the cnemial process of the tibio-tarsus, in the case of the growing Cormorant, next sets in, which, owing to the morphology of the parts involved, would, in time, depreciate the action of the knee-joint. This is clear when we come to consider the origins and insertions of the various muscles about the knee-joint anteriorly, posteriorly, and laterally *. These, during their continued action in locomotion—especially during the act of swimming—tend to overcome the aforesaid danger, militating against the complete freedom of action of the knee-joint. Coössification steadily proceeds; the individual grows; a constant tugging is exerted during locomotion at the tibio-tarsal cnemial apophysis. This eventually results in its becoming dissociated from the bone to which it belongs along a transverse line, at a short distance above the level summit of the tibio-tarsal shaft, thus leaving the lower third of the cnemial

* Shufeldt, R. W. 'The Myology of the Raven,' p. 187, figs. 51–53, London 1890.

process where it occurs in all birds when such an apophysis is present *.

In the Phalacrocoracidæ, then, the patella is a compound bone, consisting of the true patella posteriorly, and the upper two-thirds, more or less, of the cnemial process of the tibio-tarsus anteriorly, which latter has become dissociated and thoroughly coössified with the former. By this union, a foraminal passage is formed for the ambiens muscle, and this, in some species, may gradually, but entirely, disappear, whereupon, in time, the muscle meets its usual fate.

For very obvious reasons, the patella is very large in Harris's flightless Cormorant (*Nannopterum harrisi*); indeed, in so far as I have been enabled to discover, it is larger in this species than in any other existing form of the entire family (Pl. LXI. figs. 1 & 2). It has an average height of 25 millimetres, the longest diameter of its base being 19 or 20 millimetres, and is nearly a square in outline. Posteriorly, it is flat and triangular, the acute angle being above. Above its middle, and nearer its posterior surface than its anterior margin, it is pierced, transversely, by the foramen for the ambiens, which is of considerable size. Externally, its exit is almost flush with the surface of the bone, while on the inner aspect it is situated at the base of an extensive concavity. Anteriorly, this compound bone exhibits a uniform longitudinal excavation which, when the patella is articulated as in life, is the continuation with the similar excavation between the pro- and ectocnemial processes of the tibio-tarsus. On the anterior face of this patella, at the lower-internal angle, there is a transverse, triangular facet which is intended for articulation with the superior border of the cnemial crest of the tibio-tarsus. In fig. 2 we have the mesial or inner aspect of the *left* patella of *N. harrisi*, from the same skeleton (No. 19719), where the perforating foramen for the ambiens is seen at the base of the aforesaid extensive concavity. A study of these two patellæ reveals the nature of the composition of the bone as a whole, as described above.

Phalacrocorax penicillatus possesses only a medium-sized patella, which is elongate and wedge-shaped. It has the general form of the patella in *Nannopterum*: but the transverse foraminal passage for the ambiens has been entirely absorbed,—not a vestige of it remaining in an individual of the age to which this patella belonged. The union of the two parts composing the bone is very complete, and all traces of their origin have been entirely obliterated,—that is, beyond the anterior rotular channel, and the here extensive facet below it for articulation with the cnemial process of the tibio-tarsus.

This is a most excellent example of the patella in a Cormorant

* This is the part referred to by Coues in his 'Key' (5th ed. vol. ii. p. 961), where he describes the patella in the Phalacrocoracidæ in the following words: "There is a bulky free patella, coexistent with a short cnemial apophysis or rotular process of tibia, but perfectly distinct therefrom, as in Grebes." It is very evident from this definition that Coues had never given the patella of a Cormorant any very close study.

showing the conditions described as they occur in a very old bird (figs. 3 & 4), and they are equally well shown in the patella of *P. punctatus* (figs. 5 & 6), where the foraminal passage has likewise entirely disappeared. The rotular channel in front is very narrow and pointed above, as in a Grebe or Loon, and there is a rounded notch on the superior border of the cnemial process of the tibio-tarsus, which marks the limitation, externally, of the facet for articulation with the patella on that border (fig. 6, where this "notch" is plainly seen). This patella gives barely any hint as to the two parts of which it is composed.

This is to a less degree true of the patella of *Phalacrocorax magellanicus* (figs. 7 & 8); for here again we find the foraminal passage in its very last stages of ultimate absorption, while the continuation of the rotular channel on the anterior face of the patella, and the evidence of this part of the patella once having belonged to the tibio-tarsus, is very complete (fig. 7, which should be compared with fig. 6, the former in no way recalling the form of these bones in the Grebe).

Phalacrocorax urile (Nos. 19655 & 18982) has, in old individuals, a rather bulky patella (figs. 9, 10, & 11), in which, in the specimens selected, the foraminal passage is reduced to capillary proportions, and the sutural traces of the elements composing it have become nearly obliterated. Fig. 10, which is from the right limb of *P. urile*, No. 18982 of the Collection of the U.S. National Museum, shows the minute entrance to the foraminal passage; while in fig. 11, it being the left limb from the same skeleton, the opposite opening is in view,—posterior to two other foramina which occur here. Fig. 11 is given on the plate, to the exclusion of the patella of *Phalacrocorax carbo*, for the reason that in no Cormorant, other than *P. urile*, do we find, on this anterior view, a better example of the intercnemial channel on both the big sesamoid and the tibio-tarsus, and the line between them where they eventually parted company.

Phalacrocorax carbo (No. 18850, Coll. U.S. Nat. Mus., not figured) has a patella that is an interesting one in several particulars. On its inner aspect the surface is flat and smooth, the minute opening of the almost entirely absorbed foraminal canal being situated far posteriorly upon it. In size and general form the patella of this Cormorant is much like the one shown in figs. 18 & 19 of *P. pelagicus*; while it likewise possesses characters peculiarly its own. It has the usual trihedral form, and makes rather more than the average articulation with the tibio-tarsus in extent, especially on the proximal margin of the procnemial process. Its posterior face is triangular and flat, while the external one is pierced near its middle by the outer opening of the foraminal passage. Anteriorly, the usual intercnemial channel is present, it being continuous with the same on the tibio-tarsus. On the patella it is unusually narrow, and faces very much to the outer side.

Phalacrocorax carbo (No. 18851) has the patella almost exactly like that in *P. urile* (figs. 10 & 11.) The former,

however, in this particular individual, has completely lost the foraminal passage, while otherwise the morphology is quite the same.

One of the most interesting forms of the patella among Cormorants is found in *Phalacrocorax vigua* (figs. 12 & 13); for it is not only very small and chunky, but the facet on its infero-anterior aspect for the tibio-tarsus is relatively, as well as actually, large. On the inner aspect, the big foraminal opening is situated at the base of a fossa, as in *Nannopterum harrisi*, while on the external side it is small again, and has, leading down from it to the lower border of the bone, a deep groove, which not only indicates the suture between the two elements composing this bone, but apparently the continuation of the groove for the ambiens as well.

Passing to *Phalacrocorax auritus* (No. 19262), the patella of which species is shown upon two views in figs. 14 & 15, we find that that sesamoid is rather small for a Cormorant of its size. In it, the foraminal passage has gone entirely, while the bone, upon the other hand, shows better than any other Cormorant's patella I have examined, the two parts of which it is composed. These are very plainly to be seen in the figures,—indeed, equally as well as in the specimens themselves.

There is a large patella in *Phalacrocorax albiventris* (No. 18437, figs. 16 & 17), where again we find, in the adult bird, the foraminal passage almost obliterated, having been reduced to a capillary calibre throughout. Sutural traces between the bone are faint, while anteriorly the rotular excavation is broad and deep, being but slightly wider at the top than it is at the distal border.

A most instructive patella is found in *Phalacrocorax pelagicus* (No. 19032, figs. 18 & 19). Once more we find the foraminal passage reduced to a very small calibre, though the entrances on the inner and outer surfaces of the bone are still in evidence, though very small. What is to be specially noted among other things is, however, the position of the foraminal aperture on the inner aspect (fig. 18); this is but 4 millimetres from the posterior margin of the patella, while it is 9 millimetres from the anterior margin, which is sufficient to render the theory of the "anterior" groove being filled in by an ossified fibrous ligament—ridiculous.

In its amalgamation and coössification of its parts, this patella became to a large degree twisted,—a twisting that cannot well be appreciated in the figures. Still, the bone fits most accurately on the superior border of the cnemial process of the tibio-tarsus,—its lower border, antero-posteriorly, being no thicker than is that of the leg-bone, while everything in its morphology plainly indicates its origin. On the front of the patella, the rotular channel is somewhat shallower than usual, and is as broad above as it is below, where it, in all particulars, directly continues the corresponding channel separating the pro- and ectocnemial apophyses of the tibio-tarsus.

The obliquity of the foraminal passage for the ambiens is easily made out, its higher aperture being on the inner aspect of the bone, and situated, as I have pointed out above, far back from the antero-internal border of the bone. To best appreciate the fact that this sesamoid in *P. pelagicus* is formed as I have demonstrated it to be in Cormorants of all species, it should be viewed from above rather than from either side or in front.

EXPLANATION OF PLATE LXI.

[All the figures are reproductions of photographs made by the author direct from the specimens. Each bone is of natural size, and from an adult individual. They are from skeletons in the Collections of the U.S. National Museum, the Museum numbers of which are given under the figures.]

Fig. 1. Right patella of *Nannopterum harrisi*; antero-lateral aspect. (No. 19719.)

2. Left patella of *N. harrisi*; mesial or inner aspect. (No. 19719.)

3. Right patella of *Phalacrocorax penicillatus*, antero-lateral aspect, or the same view in which fig. 1 is shown. (No. 18535.) Note that the foraminal passage for the ambiens has been entirely absorbed.

4. Left patella of *P. penicillatus*; inner aspect. (No. 18535.)

5. Left patella of *Phalacrocorax punctatus*; inner aspect. (No. 18282.)

6. Left tibio-tarsus of *P. punctatus*; anterior view, with the patella articulated *in situ*. (No. 18282.)

7. Right tibio-tarsus, anterior view, of *Phalacrocorax magellanicus*, with patella articulated *in situ*. (No. 18438.)

8. Left patella of *P. magellanicus*; inner surface. (No. 18438.) Note that the exit of the foraminal passage points to the fact that it is in the very last stages of its ultimate disappearance. This is an interesting link in the chain of evidence on the real composition of this bone in the Phalacrocoracidæ.

9. Proximal extremity of tibio-tarsus and fibula of right pelvic limb of *Phalacrocorax urile*; adult. (No. 19655.) Outer aspect, with patella and femur articulated *in situ*.

10. Inner aspect of the bones composing the knee-joint of *P. urile*; partly ligamentous. (No. 18982.) Right pelvic limb.

11. Left patella, tibio-tarsus and fibula (superior moieties), anterior aspect; left pelvic limb of *P. urile*. (No. 18982.) Note the complete union and the continuation of the rotular channel of the tibio-tarsus on the anterior face of the patella.

12. Right patella of *Phalacrocorax vigua*; outer surface. (No. 18479.) Note groove leading down from the foraminal opening.

13. Left tibio-tarsus of *P. vigua* (No. 18479), with patella articulating *in situ*.

14. Bones of the knee-joint of *Phalacrocorax auritus* ("*P. dilophus*," No. 19262.) Right pelvic limb, inner aspect. Femur somewhat displaced, but patella properly articulated.

15. Bones of the knee-joint of *P. auritus* (No. 19262); left pelvic limb, outer aspect and articulated *in situ*. Note the line of demarcation between the true patella and the anterior part of the bone, which originally belonged to the tibio-tarsus.

16. Anterior aspect of the proximal extremities of the left tibio-tarsus and fibula of *Phalacrocorax albiventris*, with the patella duly articulated above them. (No. 18437.) The rotular channel is very broad in this species and rounded above.

17. Right patella, inner surface of *P. albiventris*. (No. 18437.) The foramen is almost closed up.

18. Bones entering the knee-joint of *Phalacrocorax pelagicus*, adult, nat. size. Right pelvic limb, outer aspect. Ligamentous preparation with femur slightly luxated. Patella *in situ*. (No. 19032.)

19. Skeleton of the knee-joint of *P. pelagicus*. (No. 19032.) Left limb, outer aspect; patella *in situ*.